Appendix A
Water Detection Response Team

A-1. Concept. In a combat environment, well-drilling production supplies the water requirement. Groundwater sources must be located quickly before committing well-drilling teams. Terrain teams assigned to theater-, corps-, and division-level units make recommendations on well-drilling sites. If the geographic information the military provides the terrain teams is insufficient, terrain or well-drilling teams determine well-drilling sites by *best-guess* methods. Also, terrain teams are not trained or equipped in groundwater detection techniques. Because of these limitations, the WDRT concept was developed to increase the overall effectiveness of well-drilling operations. Professionals and state-of-the-an equipment help accomplish the roundwater detection mission.

The subsurface WDRT consists of US government personnel who support military well-drilling operations by performing groundwater detection. Civilian contractors may also be used. The WDRT provides technical skills in remote sensing, geophysics, geology, and hydrology. The WDRT currently consists of on-call federal civilian employees who respond within 48 hours to a request to assess the subsurface hydrological situation any place in the world. Plans for on-call military personnel are also being developed. The team recommends drilling sites that have the best potential for producing water to meet tactical requirements. Specialists are drawn primarily from the Corps of Engineers. Other government organizations, such as the United States Geological Survey (USGS), participate when needed. Corps of Engineers' organizations include the--

- US Army Corps of Engineers Topographic Engineering Center (TEC).
- US Army Corps of Engineers Waterways Experiment Station (WES).
- Transatlantic Division (TAD).
- Mobile District, Savannah District, and other Corps' Districts.

A-2. Organization. The WDRT consists of four functional elements: data base, remote sensing, supporting specialists, and geophysical. The TEC-Terrain Analysis Center (TAC) manages WDRT and provides leadership for the data base and remote sensing elements. The geotechnical laboratory at WES provides leadership for the supporting specialists and geophysical elements. The supporting specialists consist of civilian personnel who are geographers, botanists, hydrogeologists, foresters, well drillers, and area experts. A working team is selected and mobilized within 48 hours of a validated tasking. The team may convene at the TEC-TAC to begin work by reevaluating data and imagery for the area of interest. The knowledge of the team and available information may be sufficient to identify areas with high potential for developing water sources. Additional information, such as data from remote-sensing systems and hydrogeologic data, may be acquired from other sources.

A-3. Deployment. If data is still insufficient, WDRT will select and specify areas for conducting field reconnaissance and geophysical surveys. Depending on mission requirements, a team may deploy before or with the well-drilling team to assist with site selection and well design. Team members contact host-nation groundwater experts, evaluate any existing local groundwater sources, and conduct detailed hydrogeologic reconnaissance of areas previously identified as high potential water sources. The geophysical element of the team has the capability to conduct electrical resistivity, seismic refraction, and other geophysical surveys to assist in this field work. Once the well drillers begin drilling, the supporting specialists can assist with well design, drilling expertise,

and on-site geologic support. On-site geologists assist in logging and interpreting cuttings from the well and with down-hole geophysical logging, when necessary. Down-hole logging is crucial in identifying the highest water-producing zones during rotary mud drilling.

Subsurface geophysical surveys take time. If the geophysical element of WDRT deploys, enough lead time must be allotted for the team to conduct surveys. Planners overseeing contingency plans should include WDRT work in their plans. Much of the work can be done before drilling by specifying areas of interest so that data and imagery can be collected, analyzed, and placed on file. Planners should inform WDRT of the following:

- Size of unit to be supported.
- Type of unit.
- Quantity and quality of acceptable water.
- Duration of requirement.

The WDRT usually deploys on military cargo aircraft with detection equipment packages of up to 1,000 pounds of geophysical equipment. Once deployed, WDRT maintains this equipment, shipping it back to the owning agency for contract repair, if necessary. For seismic work, WDRT may use small explosives (some of which may be standard military block explosives). The explosives are binary in nature and are mixed in the hole before detonation. The area commander supports the WDRT with logistical and administrative support to include transportation, shelter, medical support, communications, food, water, and other classes of supply.

A-4. Operational Concept and WRDB. Army commanders or staff officers who require the potential well-site locations should contact the supporting Army Engineer Terrain Team. This team evaluates available data, especially the data supplied from the WRDB. The TEC-TAC is responsible for producing and maintaining the WRDB. The WRDB provides information on quantity, quality, and availability of water resources worldwide on an areal or point basis. This information helps commanders make water-support logistics decisions and supports the Defense Mapping Agency's (DMA) terrain-analysis program. The data base includes hard-copy thematic overlays (1:250,000 scale base maps) that show the location, quantity, quality, and accessibility of existing water resources, surface water supplies, and potential groundwater sources in selected arid regions in Southwest Asia. The terrain team evaluates the database and responds directly to the requester, if sufficient data is available. If no data is available or if more information is needed, a WDRT could be formed. The terrain team sends a request for assistance in locating groundwater supplies through Army Command channels to the US Army TEC-TAC. The WDRT manager at TEC-TAC designs a team from the on-call roster.

The chain of command for other components from unified or specified commands to request data is the Terrain Team of the Army component command or through command channels, Joint Chiefs of Staff (JCS), and DA. Locating and evaluating water supplies in an area would be conducted in an integrated systems manner, beginning with data-base querying and followed by examining imagery and maps. The support command would decided which areas needed additional surveys. A WDRT may be deployed to conduct field geologic reconnaissance and geophysical surveys. Geologic reconnaissance will often be conducted without actual geophysical surveying. All available information, including field reconnaissance, will be used when categorizing potential well-drilling sites for the supported unit.

A-5. Water Resources Overlays. The product of WRDB is a set of three transparent overlays keyed to standard 1:250,000 scale Department of Defense (DOD), Joint Operations Graphics (JOG) topographic maps. The overlays provide the most current information for existing water-supply facilities, surface-water resources, and groundwater resources. The three overlays should always be used together to determine the water-supply potential of the area.

a. *Existing-Water-Supply Overlay.* An existing-water-supply overlay displays all known man-made or improved facilities except for surface water bodies larger than 0.25 square kilometeters, canals, wells, springs, and qanats. This overlay also shows the location, capacity, and quality of water in existing production, distribution, and storage facilities. These facilities include desalination, waste treatment and other purification plants, storage facilities, pumping facilities, pipelines, and miscellaneous supply facilities, such as ice-making and water-bottling plants.

b. *Surface-Water Overlay*. A surface-water overlay supplements the map and depicts surface-water resources, such as perennial water bodies (lakes and reservoirs), streams and rivers, dams, canals, and surface-water access areas. The overlay will contain information, if available, on water volume, flow rates, quality, and seasonality of water.

c. *Groundwater Overlay*. A groundwater overlay concentrates on groundwater potential. If existing facilities cannot meet field water-supply needs, planners should use the surface and groundwater overlays to determine where and when to drill water wells. If planners decided to develop a water well, they should look at the information on the groundwater resources to help site the well. The drilling unit should also have this information to execute a successful completion. Whenever possible, the WDRT should assist by recommending specific drilling sites.

Military terrain analysts and well-drilling planners use the groundwater overlay to identify areas of groundwater resources. Using the overlays greatly increases the potential of siting and developing successful water wells. From the overlay, areas of greatest groundwater potential can be determined, along with the expected characteristics of the aquifer and overburden (material to be drilled through to reach the aquifer).

d. *Overlay Symbols.* Potential water sources, where a point feature is located, are depicted by symbols and include water wells, well fields, springs, and qanats. Symbols that appear on the overlay with an adjacent number are keyed to a table with additional information. The areas of potential groundwater development are designated as Good(G), Marginal(M), Poor(P), or Unsuited (U). Areas of similar potential groundwater development may be further subdivided and designated with number suffixes such as M 1 and M2. Each potential area is keyed to a characteristics table printed in the margin of the overlay. These characteristics describe the potential yield of a well, depth to aquifer, aquifer thickness, water quality, overburden materials, and aquifer materials. Each area designated will have a set of groundwater characteristics associated with them. The characteristics are given a numeric code that places them in one of four classes.

The rock types listed under overburden materials and aquifer materials should be considered only representative of the properties and not exact geologic descriptions. The driller can expect the hardness of the overburden to increase as the class number increases from 1 to 4. Aquifer-material classes indicate the more favorable aquifer in terms of yield and ease of drilling; the greater the number, the less favorable the aquifer. Sand and grovel aquifers consist of unconsolidated materials with a large percentage of unfilled pore space. These aquifers are usually the best regarding yield

and ease of drilling. Igneous aquifers are usually the largest and have the least amount of porosity and hydraulic conductivity and may be tough to drill through. Sandstone and limestone aquifers have properties between sand and grovel and igneous aquifers. If a limestone aquifer is cavernous and is expected to yield large quantities of water, the analyst preparing the overlay could rate the aquifer as a 2. This rating indicates that the aquifer material is better than the 3 rating normally assigned to limestone.

A-6. Potential Drilling Areas. The following are reasons for areas to be eliminated or marked as unsuitable well-drilling sites:

- If an aquifer is more than 1,500 feet deep, because military well-drilling machines cannot reach that depth.
- If no significant groundwater exists.
- If successful well completion is unlikely because of overburden materials, limited aquifer extent, or groundwater barriers restricting water flow.

Besides map legends, *Supplemental lnformation* should include detailed statements on seasonal groundwater fluctuations, bacterial contamination, geology, and other pertinent information. Feature, with numbered symbols on the overlay, are entered into a *Potential Water-Data Table.* The numbered features include information on the following:

- Well location.
- Well yield.
- Water quality.
- Well depth.
- Overburden and aquifer materials.
- Well use.
- Water-chemistry data.
- Water fluctuations.
- Feature names.

Numbered features on the overlay may also be keyed into a *WRDB Analyst Report Form-Record Characteristics* form that allows for the recording of particular technical information on the feature. Information such as construction and design of existing wells, pumping test results, and other data that will aid in the design of new wells or assist in the maintenance of existing wells should be included. Most overlays are classified SECRET or CONFIDENTIAL. To order overlays, write to US Army Topographic Engineer Center, ATTN: CETEC-TC-H, Fort Belvoir, Virginia 22060-5546, or call DSN 345-2921 or commercial (703) 355-2921.